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Bachelor's Thesis

The Relationship between Implicit STEM Ability Beliefs and Educational STEM Choices:

Investigating the mediating role of gender stereotypical beliefs

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Abstract

Despite the widely accepted view that implicit ability beliefs affect girls' intention to opt for a STEM study, it remains unclear if gender stereotypical beliefs also could play a role in this relationship. One suggestion from previous literature is that these implicit beliefs could have an impact on the internalization of gender-stereotypical beliefs which could affect the intention to choose for a STEM-educational study path. Therefore, this study aims to investigate this relationship by exploring the mediating role of the internalization of gender stereotypical beliefs on the relationship between implicit STEM ability beliefs and STEM intention. A survey examined the malleability of STEM beliefs, the internalization of gender stereotypes, and the STEM field aspiration of secondary school students in their fifth-grade who already chose for a STEM-oriented track (n = 110). It appeared that the survey had good internal consistency and good content validity. Additionally, this study was not able to find a direct relationship between implicit STEM ability beliefs and STEM intention nor did it find a mediating role of gender stereotypes on this relationship. Therefore, this study showed the promising result that the 'leaking STEM-pipeline' cannot be explained by implicit STEM ability beliefs and gender stereotypes for fifth-grade female preparatory university students who already chose a STEM-oriented track. Nevertheless, the study found a significant relationship between achievement and intention to opt for a STEM-study, suggesting that achievement influences educational STEM choices. These findings provide a foundation for further research that should investigate other explanations for the leaking STEM-pipeline to be able to stimulate and motivate females for the STEM field.

Keywords: STEM, STEM Education, Gender Stereotypes, Implicit Ability Beliefs, Educational Choices.

Dutch Summary

In Nederland is er de laatste jaren een actief beleid om de keuze voor een N-profiel bij meisjes te stimuleren. Deze inspanningen werpen de vruchten af die terug te zien zijn in een stijging van de keuze voor bèta-profielen bij meisjes. We zouden verwachten dat deze ontwikkeling ook terug te vinden is in een stijging van meisjes die voor een bètastudie kiezen. Helaas is dit niet het geval, dit wordt ook wel de 'lekkende techniekpijplijn' genoemd. Onderzoek heeft aangetoond dat dit effect mogelijk te verklaren is vanuit verschillende factoren, zoals sociaaleconomische, maar ook psychologische factoren. Vanuit de psychologische invalshoek is de geringe keuze van meisjes voor bètastudies mogelijk te verklaren door een laag zelfbeeld, een vaste mindset, en stereotype beeldvorming. Deze stereotype beeldvorming houdt in dat bètastudies als 'mannelijk' worden gezien. Uit onderzoek blijkt dat deze stereotypering van bètastudies in Nederland veel sterker is dan in andere landen internationaal gezien.

Er is al enig onderzoek uitgevoerd naar de invloed van een vaste mindset op de intentie om voor een bètastudie te kiezen. Echter, of gender stereotype gedachten in deze relatie ook een rol spelen is nog niet bekend. Een suggestie vanuit eerder onderzoek is dat een vaste mindset invloed heeft op de internalisering van gender stereotype opvattingen over bètastudies die uiteindelijk weer de intentie om voor een bètastudie te kiezen beïnvloeden. Het doel van dit onderzoek is daarom om de mediërende rol van gender stereotype gedachten te onderzoeken. Dit is gedaan door een vragenlijst af te nemen bij meisjes in de vijfde klas van het VWO met een N-profiel dat al gericht is op bètavakken. Uit deze vragenlijst is gebleken dat zowel stereotype opvattingen over bèta en het hebben van een vaste mindset niet correleren met de intentie om voor een bètastudie te kiezen. Dit is een hoopgevende bevinding, omdat dit suggereert dat de lekkende techniekpijplijn bij meisjes uit 5VWO met een N-profiel niet te verklaren valt door het hebben van een vaste mindset en gender stereotype opvattingen. Verder is uit de vragenlijst gebleken dat de cijfers van de meisjes positief correleerden met de intentie om een bètastudie te kiezen. Dit suggereert dat meiden met hogere cijfers sneller voor een bètastudie kiezen.

Deze bevindingen geven suggesties voor vervolgonderzoek en ideeën voor de praktijk. Vervolgonderzoek zou zich kunnen richten op andere mogelijke redenen om de lekkende techniekpijplijn te verklaren om meiden te stimuleren en te motiveren om voor een bètastudie te kiezen. Verder zouden interventies die focussen op de gedachtes, overtuigingen, en de gevoelens van meiden kunnen helpen om hun academische vaardigheid te stimuleren en ze bewust te maken van het brede beroepenveld van de bètarichting.

Table of contents

1. Introduction

Since 2013 there is an intense policy action in The Netherlands on stimulating the take-up of Science, Technology, Engineering and Mathematics (STEM) studies by secondary-school students (Van den Broek, Deuten, & Jonkers, 2018). The efforts made within secondary and higher education did have a positive impact. In 2019, Dutch female secondary students are increasingly choosing a STEM-oriented study path in secondary school. Specifically, from the girls who are doing a university preparatory education (VWO), 59% choose such a STEM-oriented study path (Techniekpact, 2019). These students are the prospective candidates for higher STEM education. Therefore, the increase in the popularity of the technical or natural science sector/profile would be expected to be reflected in the statistics of higher STEM-education. Unfortunately, the increased number of girls choosing a STEM-oriented study path in secondary school does not match the number of girls opting for an advanced STEM study. Namely, only 27% of the girls choose a STEM-study at the university (Techniekpact, 2019). This can be described as the so-called ‘leaking STEM-pipeline’ (Tuijl & Walma van der Molen, 2016).

Although previous research already identified various factors that influence the choice for a STEM study (Van Tuijl & Walma van der Molen, 2016), it remains a challenge to positively stimulate girls' STEM interest. It seems that implicit beliefs are certainly important as studies show that explicit beliefs seem to be influenced by implicit beliefs (Blackwell, Trzesniewski, & Dweck, 2007; van Aalderen-Smeets & Walma van der Molen, 2016; Nix, Perez-Felkner, & Thomas, 2015). Van Aalderen-Smeets and Walma van der Molen (2018) opted for the importance of implicit ability beliefs in the intention to choose for a STEM study. They presented three hypothetical pathways that describe potential relations between the implicit STEM ability beliefs and students’ intentions to pursue a STEM career. Each pathway outlines a specific mediating factor influencing this relation: (a) self-efficacy beliefs, (b) stereotypical thinking, and (c) motivational beliefs. Van Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou (2019) tested the mediation model for self-efficacy beliefs and they concluded that the relationship between the implicit STEM ability beliefs and the STEM intention is partially mediated by self-efficacy beliefs. The current study focused on testing the second suggested pathway of Aalderen-Smeets and Walma van der Molen (2018) for female preparatory university students who already chose for a STEM-oriented track in high school. Hence, this paper examined whether the relationship between implicit STEM ability beliefs and educational STEM-choices could be mediated by gender-stereotypes.

1.1. The Complexity of Reasons for the Lack of Girls in STEM-Studies

Traditionally, The Netherlands lagged far behind other countries in terms of percentage of girls choosing for STEM profiles and study programmes. According to Eurostat statistics (2016), there is a large underrepresentation of girls in STEM-studies in The Netherlands compared to other European countries. This low underrepresentation in STEM-studies starts with thinking about a study which refers to a set of activities, such as orienting, planning and decision-making (Hirschi, Niles, & Akos, 2011). The lack of interest in high school students in STEM-studies is a complex problem and the reasons are manifold.

There are different processes through which contextual and intrapersonal factors may influence the choice of studying a STEM-study. To begin with environmental influences such as parental influences (Bryant et al., 2006) that can be divided into structural factors and process factors. Structural factors are, for instance, income and educational level, whereas, process factors are, for example, role modelling and having high expectations of children. Other contextual influences are socio-cultural (Ceci et al., 2009; e.g. life choices; career vs. family) and socio-historical influences (Schoon et al., 2007; e.g. parental social class).

Next to environmental influences, there are intrapersonal factors involved. Examples of psychological factors that play a role in opting STEM-studies are motivation (Watt et al., 2012), interest (Nye et al., 2012), ability beliefs (like self-efficacy: Lent et al., 1994), and gender-stereotypical thinking. Watt et al. (2012) demonstrated that there are gender differences in mathematical motivations favouring male adolescents. Furthermore, a meta-analysis suggested that interests are predictors of performance in work and academic domains (Nye et al., 2012). Next to the importance of motivation and interest, another meta-analytic review indicated that ability beliefs seemed to be important, especially self-efficacy (Lent et al., 1994). As an example, math-related self-efficacy beliefs are lower for females than for males, even though they have similar math grades (Else-Quest, Hyde, & Linn, 2010; Nix, Perez-Felkner, & Thomas, 2015).

A possible reason to explain this low self-efficacy is students' implicit beliefs about the malleability of their learning abilities (Dweck, 2000). According to Dweck’s (2000) motivational model of achievement, some students consider their abilities as fixed or as an unchangeable entity (entity beliefs), while others consider their abilities as characteristics that can be changed and developed through experience and practice (incremental beliefs). Girls with low self-efficacy tend to have entity beliefs regarding their intelligence (Dweck 2006; Nix et al. 2015; Zimmerman, 2000), so they believe that their ability is unchangeable. As an example, when these students face a drawback, they are likely to attribute this to a lack of innate ability.

An example thought could be *"I just don't get this material; I am not capable of getting an A in this course"* (Zimmerman, 2000). Thus, another explanation put forth for the gender disparity in STEM-studies is that girls tend to underestimate their abilities to be successful in these fields (Correll, 2001; Ehrlinger & Dunning, 2003). These implicit ability beliefs could not only be important for the level of self-efficacy but potentially also affect gender-stereotypical beliefs. Even though all the other mentioned factors (e.g. self-efficacy, motivation, interest) play a role in choosing a study, this paper will only focus on gender stereotypes and implicit ability beliefs.

1.2. The Development of Gender-Stereotypes

Gender stereotyping reflects societal norms of personal characteristics, activities, studies, occupations, and lifestyles that are considered appropriate for men or women (Van Tuijl & Van der Molen, 2016). The gender stereotypes result in a negative affective value adhered to STEM-studies. There is a false idea that STEM-studies are 'male-oriented and a threat to a feminine lifestyle' (Van Tuijl & Van der Molen, 2016). This idea is transferred through, for instance, parenting, education, and the media.

From an early age, children begin to show typical interests and behaviour. Pre-schoolers already associate clothes, toys, colours, and occupations with one gender or another. This is also reflected in their behaviour and interests. In other words, children tend to behave in a way culture determines as appropriate for their gender (Berenbaum, Martin, & Ruble, 2008). One psychological theory that explains this process is the social learning theory that argues the reinforcement of suitable gender-typical behaviour by important others such as teachers and parents, as well as indirect learning via modelling and observation (Bandura, 1997; Mischel, 1966). According to Bem (1983), children observe their environment and then learn the various associations with masculinity and femininity, their societal roles, and the characteristics of each gender. Consequently, children adjust their behaviour to conform to the gender-typical norms of their culture. In this process, parenting, schools, and the media serve as important factors. The gender-schema theory proposes, additionally, that children learn to recognize and organize incoming information in gender-based categories, in other words, the gender schemas. These schemas comprise information that filter perceptions before the child is aware of this process. This process involves automatically sorting behaviours, objects, and attributes into masculine and feminine categories. The gender-schemas are continuously changing since a child develops but they are mostly similar in children growing up in the same cultural context because of the cultural gender stereotypes.

1.3. Placing Gender-Stereotypes in their Context and the Effect of Role Models

Compared to other international countries (e.g. Australia, Sweden, UK, and Iran), The Netherlands has a much stronger explicit and implicit stereotypical image of ‘masculinity’ towards STEM studies. Miller, Eagly, and Linn (2015) showed that The Netherlands had the strongest explicit and second strongest implicit gender stereotypes compared to the other 66 investigated nations (e.g. USA, Canada, Russia, Egypt, Australia, and Iran). The reason for this high score according to Miller, Eagle, and Linn (2015) is the high domain-specific gender segregation, whereby male scientists outnumber female scientists nearly four to one in both educational and employment enrolment. This lack of role models can also already be seen in the number of girls opting a STEM-study. Specifically, according to Eurostat statistics (2016), there is a large underrepresentation of girls in STEM-studies in The Netherlands. Clearly, there is a problem of a lack of female role models in the STEM fields in The Netherlands. This lack has negative consequences for the perceived image of STEM field because role models are essential.

Female role models are meaningful because one common way to convey to women that they can be successful in STEM is to expose them to a STEM role model, or someone who is successful in these fields and can be mimicked (Lockwood & Kunda, 1997; Marx, Stapel, & Muller, 2005). Seeing a female who exhibits traits compatible with how girls see themselves may arouse the sense of belonging that girls need to become interested in STEM (Cheryan, Drury, & Vichayapai, 2013). Hence, girls need to identify themselves with the STEM-field. Drury, Siy, and Cheryan (2011) argue that maximizing a sense of perceived similarity to role models is key in recruiting women in STEM-studies. So, the lack of female role models in STEM fields in The Netherlands has consequences for how the STEM fields are perceived.

In conclusion, it is not the case that girls are less capable in STEM than boys. It is rather the case that implicit gender-stereotypical beliefs from their environment (e.g. parents, and teachers) encourage boys to join the STEM field and that discourage girls (particularly in the Netherlands). The conception of such stereotypical beliefs in society may prevent the next female generation from assuming they can achieve success in STEM.

1.4. The Interrelation of Implicit Ability Beliefs and Gender-stereotypes

Implicit ability beliefs and gender-stereotypes are potentially all interrelated. Dweck's motivational model (2008) claims that implicit ability beliefs determine how sensitive students are to stereotypical beliefs. She assumes that people with a growth mindset are less sensitive for stereotype-thinking (Dweck, 2008) as van Aalderen-Smeets and Walma van der Molen (2018) also hypothesized in their paper. This relationship is tested experimentally, for instance, Aronson, Fried, and Good (2002) conducted an experiment where students in the experimental condition were encouraged to see intelligence – the object of the stereotype – as a malleable rather than fixed capacity. This mindset appeared to make students less vulnerable to stereotype threat. Good, Aronson and Inzlicht (2003) performed to some extent a similar experiment to test methods of helping female, minority, and low-income adolescents overcome the anxiety-inducing effects of stereotype threat and, consequently, improve their standardized test scores. They also showed that it was possible to change the mindset to intervene on the stereotypical beliefs.

A mechanism that can explain these results is one that works through internalizing stereotypes (Owen & Massey, 2011). This means the person has internalized the stereotype and identifies him/herself with the target group. Consequently, the stereotype threat becomes a self-fulfilling prophecy. In the context of STEM, stereotypes would include females who are not talented and successful in math and science. However, when people have a growth mindset, they think that their abilities are characteristics can be changed and developed through experience and practice (Dweck, 2000). Hence, they will be less vulnerable to the self-fulfilling prophecy and will, therefore, not internalize the stereotypes.

1.5. The Influence of Implicit STEM Ability Beliefs on Study Choice

Research suggests that the implicit STEM ability beliefs are malleable and that interventions directly focused on students themselves, or indirectly focused on teachers and parents can change the implicit STEM ability towards incremental beliefs which could affect study choice (Aronson et al., 2002; Blackwell et al., 2007; Good et al., 2003; Paunesku et al., 2015). Blackwell et al. (2007) showed, for instance, that students were able to improve their ability beliefs toward incremental beliefs by a large-scale intervention. In the long run, these incremental beliefs resulted in increased math performances and motivation.

Furthermore, also small-scale interventions proved their effectiveness. As a review also showed that even seemingly ‘small’ social-psychological interventions in education that target students’ thoughts, feelings, and beliefs, can lead to long-term improvements on the motivation and achievement of students (Yeager & Walton, 2011). This effect is achieved because students are stimulated to take a different perspective towards themselves and their environment which enhances the learning process. As an example, Paunesku et al. (2015) delivered online modules to stimulate a growth mindset which resulted in positive effects on the grade-point averages of students. Additionally, teachers can help stimulate a growth mindset as Good et al. (2003) showed in their study. They demonstrated that teachers who stimulate incremental beliefs by, for instance, encouraging the view that intelligence is malleable, had a positive effect on student's ability beliefs and achievement. Thus, these studies show that encouraging incremental beliefs could influence student's achievement and ability beliefs. Therefore, implicit beliefs might positively stimulate the study choice process in favour of STEM-related studies.

1.6. The Influence of Gender-Stereotypes on Study Choice

Eventually, gender stereotypical beliefs could affect study choice. Miller and Hayward (2006) reported that both males and females preferred jobs they saw as stereotypically gender suitable. For instance, computer scientists are stereotyped as 'computer nerds' who are socially awkward and obsessed with computers (Margolis & Fisher, 2002; Schott & Selwyn, 2000). In contrast, the female gender role prescribes many opposing characteristics—helping and working with others, being socially skilled, and attending to physical appearance (Cejka & Eagly, 1999; Diekman et al., 2010; Eagly & Steffen, 1984). Gender roles shape the way people see themselves (Eagly, 1987), and women report feeling dissimilar from people who fit STEM stereotypes (Cheryan et al., 2009). Besides, Schwartz and Rubel-Lifschitz (2009) found that females scored higher than males on altruistic values. Hence, women prefer jobs that offer opportunities to help people or to contribute to society. These values are against the choice of STEM fields since women think this will not favour their interests. Thus, female adolescents will be less likely to choose for STEM-studies since these are associated with the stereotypes such as 'cleverness' and 'masculinity' (Archer et al. 2012) and they think it will not fit their altruistic values (Schwartz, Rubel-Lifschitz, 2009). These gender stereotypical beliefs could also explain why females are more interested in some STEM-fields (e.g., medicine) over others (Cheryan, 2012).

One major theory that postulate that gender stereotypes are partially responsible for the choice of study is the Expectancy-Value theory (Eccles et al, 1983). This theory holds that the study choice is governed by a variety of factors. These factors could be divided into two categories; the individual's expectations for success and the values he or she attaches to different options. The expectations to success develop over childhood (Liben, & Coyle, 2014) and are shaped, for instance, by gender stereotypes. Each of the factors is influenced by cultural norms, experience, and the influence of important people like parents, peers, or teachers. According to the Expectancy-Value theory, gender stereotypes influence the choice for a STEM-study in various ways. For instance, stereotypical gender beliefs can lead to self-concepts of one's abilities that affect the expectation of success which then influences the study choice.

Another theory that explains why gender-stereotypes affect study choice is the theory of Circumscription and Compromise from Gottfredson (1996). As the name inclines, this theory states that two processes are important for career choice: Circumscription and Compromise. The process of Circumscription can be described by children who eliminate career options progressively because they perceive these options as not suitable for themselves. During this process, the gender stereotypes play a significant role. A considerable amount of career options are abandoned since they are perceived as 'masculine' (Archer et al. 2012; van Tuijl & van der Molen, 2016), not corresponding to their own identity (Cheryan et al., 2009), and not fitting to their altruistic values (Schwartz, Rubel-Lifschitz, 2009). In the second process 'Compromise', children abandon preferred career options and replace them for more accessible ones. Again, in this second process, the gender-stereotypes influence the way how children perceive STEM-related study choices and they evaluate if it matches their gender.

1.7. The Influence of Achievement

The academic achievement of females in STEM courses at secondary school could play a role in their educational choice. Watt, Eccles, and Durik (2006) suggested that achievement can be viewed as a necessary condition for making a study choice and that it is important to take achievement measures into account. The Expectancy-Value theory (Eccles et al, 1983) can explain how achievement influences the STEM-study choice as Wang and Degol (2013) explained in their review. Academic achievement shapes the expectancies and the subjective task values, which, in turn influences the educational choice (Guo, Parker, Marsh, & Morin, 2015). In other words, when females experience difficulties in math, they expect to have no success in the STEM field which affects the intention to opt for a STEM study. In this way, Rask (2010) and Wang (2012) showed empirically that having good grades in a STEM subject is favourable when deciding for a bachelor's degree in this field. Therefore, research suggests that academic achievement influences STEM intention.

However, there is not a lot of research performed on the role of achievement on gender stereotypes. Nevertheless, Appel et al. (2011) and Good et al. (2008) supported that gender stereotypes influence female's achievement. They showed that gender stereotypical beliefs lead to a decline in female achievement related to STEM subjects. Therefore, it seems that stereotypical beliefs influence female's achievement level.

Studies show that academic achievement is malleable. Yeager and Walton (2011), for instance, discussed that small scale social-psychological interventions can lead to improvements on students' academic achievement. Furthermore, Wang and Degol (2013) demonstrated that interpersonal relationships with teachers are influential on students' achievement since positive interpersonal relationships can improve students' academic achievement.

1.8. The Current study

Next to environmental and social-economic factors, implicit beliefs are important to explain why most girls do not choose for a STEM-study. In The Netherlands, especially the stereotypical image of STEM-studies as 'masculine' is of importance as research shows that compared to other international countries The Netherlands has a much stronger explicit and implicit stereotypical image towards STEM-studies (Miller, Eagly, and Linn, 2015). This suggests that these gender-stereotypes are highly interwoven in our culture.

This study will examine the correlations between STEM ability beliefs and STEM intention. Due to the Covid-19 virus, it was not possible to perform an intervention study, therefore, a correlational study was the solution. Firstly, research shows that implicit STEM ability has an influence on how sensitive students are to stereotypical beliefs (Aronson, Fried, & Good, 2002; Good, Aronson & Inzlicht, 2003; Dweck, 2008). Additionally, implicit ability beliefs might affect STEM-related study choice. This is already greatly studied (Aronson et al., 2002; Blackwell et al., 2007; Good et al., 2003; Paunesku et al., 2015; Van Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou, 2019) and, therefore the current study will replicate these studies. Furthermore, the Expectancy-Value theory (Eccles et al, 1983), and the theory of Circumscription and Compromise (Gottfredson, 1996) explain how gender-stereotypes can influence the intention to choose for a STEM-study.

The above-mentioned relationships are already investigated but not if these relationships also hold for female preparatory university students who already chose for a STEM-oriented track in secondary school. These students are potentially more interested in STEM compared to female students who do not follow a STEM-oriented track. Hence, this study focused on this group since it is not clear if stereotypical beliefs about STEM also hold for them. Furthermore, gender stereotypes could mediate the relationship between implicit STEM ability beliefs and STEM intention. There are other potential mediators (e.g. self-efficacy, and motivation) but the current study only focused on gender stereotypes. All the findings taken together led to the following hypotheses formulated based on Preacher and Leonardelli (2001):

H^1: Implicit STEM ability beliefs significantly positively affect gender stereotypes. In this way, the higher the score on the entity beliefs, the higher the internalization of gender stereotypes will be.

H^2: Implicit STEM ability beliefs significantly negatively affect the intention to choose a STEM study in the absence of the mediator.

H^3: Gender stereotypes have a significant negative effect on the intention to choose a STEM study

H^4: The effect of the implicit STEM ability beliefs on the intention to choose for a STEM study shrinks upon the addition of the internalization of gender stereotypes to the model. Hence, the relationship is better explained by gender-stereotypical beliefs. This mediation suggests that students holding entity beliefs are more susceptible to STEM-oriented gender stereotypes than students holding incremental beliefs. Consequently, these students will be less intended to opt for a STEM study.

Achievement may be a contributing variable in the relationship between implicit STEM ability beliefs, gender stereotypes, and the intention to choose a STEM study. Research already suggested that achievement could possibly influence the intention to opt for a STEM study (Guo, Parker, Marsh, & Morin, 2015; Rask, 2010; Wang, 2012; Wang & Degol, 2013; Watt, Eccles, & Durik, 2006) and influence the internalization of stereotypical beliefs (Appel et al. 2011; Good et al. 2008). Therefore, this study also explored the role of achievement on STEM intention and gender-stereotypical beliefs.

2. Method

2.1. Design and Participants

The study consisted of a quantitative cross-sectional survey-based design to examine the relationships between implicit STEM ability belief, STEM gender stereotypes, and STEM intention. This research design is beneficial since it provided substantial data within a short time period and it can be implemented with little resources (Kelley, Clark, Brown, & Sitzia, 2003). This was helpful since this study was performed during the so-called Corona crisis (Covid-19) which excluded other study methods.

The participants of this study were female students of seven secondary schools. These female students were in the fifth year of their university preparatory education (in Dutch; VWO) and chose a STEM-oriented track, in which physics, mathematics, biology, and chemistry are mandatory subjects. These students were orienting towards choosing a study at the university but still had a year (6th grade) before they had to decide.

154 female secondary school students from seven schools filled out the survey. Participants that did not finish the survey or did not fit the requirements of being female and follow STEM-related subjects (mathematics, biology, chemistry, and physics) were not part of the target group. Therefore, 44 students had been excluded from the sample. Consequently, the

total sample for data analysis consisted of 110 female students. The age ranged between 16 and 18 years [*M*(Age): 16.5, *SD*(Age): 0.57]. All respondents participated voluntary and were collected via convenience sampling.

2.2. Procedure

The ethical committee of the University of Twente approved the study. Data collection took place between the 13th of April and the 24th of April. Several secondary schools were approached via email to participate in the study. When they showed interest, a letter containing information about the study was sent to the schools so they could send this to their female students that conformed the requirements. Students filled out the survey online at their own mobile device or computer and it was accessible via an electronic link. The female students gave active consent to fill out the survey after they opened the link. The informed consent form included information about the estimated study duration (10-15 minutes), the study content (i.e. the variables to be measured), participants' anonymity, the possibility to withdraw at any time, and in case of questions, e-mail addresses of the researchers. The respondents had to accept the informed consent before starting with the actual survey. After several biographical questions (age, gender, name of the school, etc.), participants had to answer questions regarding their intent to choose for a STEM-study. Hereafter, they got randomized questions about their implicit STEM ability beliefs and their gender stereotypes towards STEM. Finally, a notification informed the respondents that they finished the survey and that their answers were recorded.

2.3. Instrument

The survey consisted of 35 items regarding the different subparts; 'biographical information', 'intended STEM choice', 'implicit STEM ability beliefs, and 'STEM gender-stereotypes' (see Appendix A). Students had to rate the items on a forced-choice Likert scale from 1 (totally disagree) to 4 (totally agree). The 4-point Likert scale had no neutral point because studies have shown that especially younger respondents are more comfortable with fewer response categories (Bourke and Frampton, 1992). This would increase reliability because participants would respond more consistently. This is also in line with the advice of educational experts because they argue that young students need to be forced to decide (Adelson & McCoach, 2009). However, it should be mentioned that the optimal number of response categories for Likert scales is still undecided (Preston & Colman, 2000). The order of the items was randomized in the questionnaire. Furthermore, all items were formulated in Dutch since only Dutch female students participated in the study.

2.3.1. Biographical information. The survey started with questions about biographical information to obtain information about the respondents' age, gender, name of the school, grade, and class number. Furthermore, this part also contained a question about academic achievement. Respondents gave their average grades on the STEM subjects of mathematics, biology, chemistry, and physics on a scale from 1 to 10.

2.3.2. STEM-intention. The STEM-intention scale consisted of six items. Three reflected a positive intention, the other three reflected a negative intention to opt for a STEM degree. These items were adopted from van Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou (2019) that also supported the construct and discriminant validity for this scale. The items started with a header stating: "When I pursue a bachelor's degree next year, I …,". This was followed by the six items, such as: "…intend to choose a study where physics and/or chemistry is required".

2.3.2.1. *Assessing the quality of the STEM-intention construct.* A Kaiser-Meyer-Olkin measure and Bartlett's Test of Sphericity screened the data to see if the data was suitable for factor analysis. The Kaiser-Meyer-Olkin measure accessed the sampling adequacy. Generally, a score of >0.60 is preferred before continuing with factor analysis. Here, the Kaiser-Meyer-Olkin measure gave a value of 0.87. The Bartlett's Test of Sphericity provided a significance level of p<0.001. Additionally, a correlation matrix was computed. This showed correlations >0.30 indicating that the data is suitable for factor analysis, as this shows that the variables are related to each other.

A factor analysis using the extraction method of Maximum Likelihood with a non-orthogonal rotation of Oblimin was conducted. Non-orthogonal rotation assumes that the factors are correlated. The aim of adding rotation is to achieve a simpler structure to facilitate interpretation of the relationship between item and factors. Factors with an Eigenvalue of >1 were selected for further analysis according to the Kaiser Criterion. Therefore, the data showed one factor with an Eigenvalue of 4.01 that explained 66.8% of the total variance. Furthermore, when using the elbow criterion, the scree plot also showed support for one factor. The factor loadings ranged between 0.64 and 0.83 as can be seen in Table 1. No items had to be deleted since the factor loadings were sufficient. Additionally, the items appeared to have excellent reliability (α = 0.90) which supported the internal consistency of the items.

2.3.3. Implicit STEM ability beliefs. The items to measure the STEM-mindset were adopted from van Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou (2019). It originally consisted of eight items and was divided into two categories of each four items. These subscales were 'entity' items and 'incremental' items as Dweck (2000) also argued in her motivational model of achievement. Van Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou (2019) adjusted the items from the Self-theory scale by De Castella and Byrne (2015) that assessed students' beliefs about their ability to change their own ability in contrast to their beliefs about the malleability of intelligence in general. Van Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou (2019) tested the construct and discriminant validity of the subscales. They concluded that there is support for the construct validity and that implicit STEM ability beliefs constituted a separate factor compared to general implicit beliefs. An example item of STEM-mindset derived from the entity subscale was: "My STEM ability is something about me that I personally can't change very much".

In the literature, there is no consensus on whether implicit ability beliefs are a multidimensional or a one-dimensional construct. Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou (2019) opted for a one-dimensional construct since their data supported this. The dataset of this study is also examined whether it followed a one-dimensional construct or a multidimensional one.

2.3.3.1. *Assessing the quality of the implicit STEM ability beliefs construct.* One item showed a suppressive effect on Cronbach's alpha and had a low communality score (<0.40). Therefore, it was decided to delete this item ("I have a certain amount of STEM aptitude, and I really can't do much to change it") which resulted in an implicit STEM ability beliefs scale of seven items that showed good internal consistency ($\alpha = 0.89$).

Again, data were screened by conducting a Kaiser-Meyer-Olkin measure and Bartlett's Test of Sphericity. The Kaiser-Meyer-Olkin measure gave a value of 0.89 and Bartlett's Test of Sphericity provided a significance level of $p<0.001$. A factor analysis using the extraction method of Maximum Likelihood with a non-orthogonal rotation of Oblimin was conducted. The data showed one factor with an Eigenvalue of 4.25 that explained 60.7% of the total variance and the scree plot also showed support for one factor by using the elbow criterion. The factor loadings ranged between 0.67 and 0.77 (see Table 1). Furthermore, the data in this study also showed support for a one-dimensional construct of implicit ability beliefs since the items loaded on the same factor.

2.3.4. STEM gender-stereotypes. The internalization of gender-stereotypes was measured by ten items divided into three subscales: interests (4 items), abilities (3 items), and conformance (3 items). The 'interests' scale measured the curiosity/interest towards STEM, 'ability' items estimated the perceived capability of girls towards STEM, and the 'conformance' subscale assessed girls' level of congruence. The items from the three subscales were based on the items of Ertl, Luttenberger, and Paechter (2017) who argued for these specific subscales to measure the internalization of gender-stereotypes. The items were created by six partners of their project and they sought and included expert judgement which heightened the content validity. This resulted in a satisfying internal consistency (α between 0.70 and 0.77) and by conducting factor analysis they concluded that their data consisted of the hypothesized subscales. For the current study, the items were translated into Dutch (see Appendix B) since they were not used before in The Netherlands. The items were also transformed from a 5-point Likert scale towards a 4-point Likert scale. Higher values indicated stronger stereotypes. An example item from the interest's subscale was: "Girls are not as interested as boys in STEM subjects".

For administrative purposes, this study chose for an explicit measurement of gender-stereotypes since several studies indicated only a small or no difference between implicit and explicit measurement. White and White (2006) compared implicit and explicit occupational gender stereotypes and found no differences. Furthermore, stronger evidence is provided by a meta-analysis on the correlation between the Implicit Association Test and explicit self-report measures (Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005). These results suggest that the two measurements are generally related but that a lack of conceptual correspondence and higher-order inferences can reduce the influence of automatic associations on explicit self-reports.

2.3.4.1. ***Assessing the quality of the gender stereotypes subscales.*** A factor analysis using the extraction method of Maximum Likelihood with a non-orthogonal rotation of Oblimin is performed to test the suggested subscales 'interests', 'abilities', and 'conformance'. The Kaiser-Meyer-Olkin measure gave a value of 0.81 and Bartlett's Test of Sphericity provided a significance level of p<0.001. The data showed that by using the Kaiser Criterion three factors could cumulatively explain 70.2% of the total variance. The factor loadings ranged between 0.46 and 0.83 (see Table 1). After rotation, one item ("Girls enjoy studying other subjects more") still showed cross-loadings between the factor's 'interests' and 'abilities', therefore, it was deleted from the dataset. Additionally, one item ("STEM subjects are more 'masculine' than other subjects") correlated more with the 'interests' subscale instead of the 'conformance' one. Consequently, this item was shifted to the 'interests' scale. The overall internal consistency of the different subscales was good for 'interests' items (α = 0.80), and acceptable for 'ability' and 'conformance' items (respectively, α = 0.78 and α = 0.71).

Table 1.

Overview of Items used in the Survey and Factor Loadings (N=110).

Items	Intent	SAB	GSI	GSA	GSC
STEM intention (intent) When I pursue a bachelor's degree next year, I…					
Intend to choose a STEM field oriented degree	0.64				
Intend to choose a degree that requires knowledge about math, science, physics, biology, or other STEM subjects	0.80				
Intend to choose a degree of which the focus is mainly on STEM subjects	0.79				
Intend to choose a degree that doesn't relate to STEM at all	0.83				
Intend to choose a degree that doesn't require knowledge about math, science, physics, biology, or other STEM subjects	0.79				
Intend to choose a degree of which the focus is not on STEM subjects	0.79				
STEM Ability beliefs (SAB)					
I don't think I personally can do much to increase my STEM abilities		0.77			
My STEM ability is something about me that I personally can't change very much		0.67			
To be honest, I don't think I can really change my STEM aptitude		0.77			
With enough time and effort, I think I could significantly improve my STEM ability level		0.76			
I believe I can always substantially improve on my STEM aptitude		0.72			
Regardless of my current STEM ability level, I think I have the capacity to change it quite a bit		0.77			
I believe I have the ability to change my basic STEM aptitude level considerably overtime		0.69			

Gender Stereotypes Interests (GSI)					
Girls are not as interested as boys in STEM subjects			0.71		
Boys are more likely to have hobbies to do with STEM subjects			0.60		
University courses in STEM subjects are likely to be more attractive to boys			0.82		
STEM subjects are more 'masculine' than other subjects			0.46		
Gender Stereotypes Abilities (GSA)					
Girls are not as good as boys at STEM subjects				0.72	
Girls have less natural ability in STEM subjects than boys				0.79	
Most girls are better at other things (like languages) and they take the subject they are best at				0.64	
Gender Stereotypes Conformance (GSC)					
To have a successful career in STEM you need to think like a man					0.83
Women who work in STEM have to act like a men					0.67
Eigenvalues	4.01	4.25	3.68	1.42	1.22
Cronbach’s Alpha	0.90	0.89	0.80	0.78	0.71
Mean	2.65	2.04	2.16	1.68	1.26
Standard Deviation	0.74	0.46	0.61	0.58	0.47

Note. Factor loadings are only displayed for items with loadings >0.40. Intent = STEM intention, SAB = STEM ability beliefs, GSI = Gender Stereotypes Interests, GSA = Gender Stereotypes Ability, GSC = Gender Stereotypes Conformance, Ach = achievement.

2.4. Data Analysis

The data was analysed using IBM SPSS Statistics 26. Missing cases were removed from the dataset and respondents that did not fit the requirements were also removed. Firstly, items (15,16, and 17) from the intended STEM choice were recoded because there were negatively formulated items. Additionally, items (22, 23, 24, and 25) from the incremental subscale of implicit STEM ability beliefs were also recoded so that they consisted of one factor. Higher values indicated stronger fixed implicit ability beliefs. Firstly, it was examined whether the suggested constructs of STEM intention, implicit STEM ability (entity, and incremental) and gender stereotypes (interests, abilities, and conformance) were clustered as intended by using factor analysis. Then, sum scores and mean scores of the subscales ‘intended STEM choice’, ‘implicit STEM ability beliefs, ‘STEM gender-stereotypes’, and ‘achievement’ were calculated and used for data analysis. Hereafter, frequencies and descriptive analyses were performed by calculating the means, and standard deviations to give an overall impression of the data. Next, a correlation analysis using Pearson’s *r* was conducted to test the relationship between the variables. Furthermore, for each variable, the Cronbach’s Alpha coefficients were investigated. A value of $\alpha > 0.70$ was assumed acceptable (Tavakol & Dennick, 2011).

Hereafter, mediation was tested. The latest PROCESS 3.4 macro for SPSS by Hayes (2018) was used to test the main and indirect effects employing bootstrapping. It is a non-parametric method based on resampling with replacement which is done many times (e.g., 5000 times). The indirect effect from each of these samples is computed and a sampling distribution is empirically generated. The independent variable implicit STEM ability beliefs, the dependent variable STEM intention, and the mediator STEM gender stereotypes (interests, abilities, and conformance) were analysed. The bootstrapping approach is more compelling than other approaches in testing mediation and it is a very up-to-date procedure to test mediation variable effects (Hayes, 2018; MacKinnon, Lockwood, & Williams, 2004). It is particularly useful in smaller samples because as Hayes (2018) recommended, bootstrap samples were set to be 5,000 and 95% confidence intervals were used. This number of samples is used because every time a bootstrap confidence interval is produced from the same data, it will provide slightly different outcomes since it is based on random resampling (Hayes, 2018). Therefore, the number of samples need to be high to minimize this difference. There is mediation when the confidence interval does not include zero. For an extensive outlay about bootstrapping see Hayes (2018).

It is chosen to use a single multiple mediator model instead of separate simple mediator models. This multiple mediator model displays the direct effect of X on Y along with the indirect effects of X on Y via the mediators (Preacher & Hayes, 2008). In this way, the total indirect effect of X on Y is the sum of the specific effects of the mediators. It could be that the specific indirect effects are not significant but that the total indirect effect is significant (Preacher & Hayes, 2008) which also holds the other way around. There are several advantages for this single multiple mediator model. First, the total indirect effect is similar to performing a regression analysis with several predictors. Additionally, the likelihood of parameter bias due to omitted variables is reduced. Thirdly, including several mediators in one model allows to decide the relative importance of the specific indirect effects associated with all mediators (Preacher & Hayes, 2008). After performing mediation analysis, the influence of achievement was tested. This was done by performing a regression analysis of achievement on STEM intention.

3. Results

3.1. Descriptive Statistics and Correlations

The relation between STEM intention, implicit STEM ability beliefs, and gender stereotypes is investigated. Frequency analysis of the mean sum scores showed that 29.1% of the respondents in this study is certain to opt for a STEM study. Furthermore, it appeared that only 2.7% of the respondents had entity beliefs and comparing the mean sum scores of the gender stereotypes subscales it showed that only a very few respondents internalized gender stereotypes (interests; 2.7%; ability; 0%; conformance; 0%).

Descriptive statistics and correlations are displayed in Table 2. The data showed three significant positive correlations between the different gender stereotypes subscales. Nevertheless, the subscales of gender stereotypes did not correlate with STEM intention nor implicit STEM ability. Furthermore, a significant positive correlation was found between achievement and intention to choose a STEM study, however, there was no correlation between achievement and the subscales of gender stereotypes.

Table 2.

Descriptives and Pearson Correlations between the observed factors (N = 110).

Variables	Descriptives			Correlations					
	M	*SD*	# *Items*	Intent	SAB	GSI	GSA	GSC	Ach
STEM Intention	2.65	0.74	6	1					
Implicit STEM Ability	2.04	0.46	7	-.14	1				
Gender Stereotypes Interests	2.16	0.61	4	-.02	.17	1			
Gender Stereotypes Ability	1.68	0.58	3	-.06	.16	.46**	1		
Gender Stereotypes Conformance	1.26	0.47	2	.04	.08	. 35**	.23*	1	

STEM Achievement[a]	6.78	0.81	.21*	-.05	.10	-.07	.08	1

Note. Intent = STEM intention, SAB = STEM ability beliefs, GSI = Gender Stereotypes Interests, GSA = Gender Stereotypes Ability, GSC = Gender Stereotypes Conformance, Ach = achievement.
*$p < 0.05$, **$p < 0.01$
[a] All scores are measured with a Likert-type 4-point scale from 1 to 4, except achievement, which is measured on a scale from 1 to 10.

3.2. Hypotheses Testing

The first hypothesis stated that implicit STEM ability beliefs significantly positively affect gender stereotypes. However, implicit STEM ability beliefs was not significant related to any of the three subscales of gender stereotypes; interests [β = 0.22, t(108) = 1.77, p = 0.08, R^2 = 0.03], ability [β = 0.20, t(108) = 1.66, p = 0.10, R^2 = 0.03], conformance [β = 0.08, t(108) = 0.85, p = 0.40, R^2 = 0.01]. Therefore, hypothesis 1 is rejected. The second hypothesis proposed that implicit STEM ability beliefs significantly negatively affect the intention to opt a STEM study in the absence of the mediator. The analysis indicated that implicit STEM ability beliefs and STEM intention were not significantly associated [Total effect: β = -0.22, t(108) = -1.44, p = 0.15]. Consequently, hypothesis 2 is rejected. Additionally, the third hypothesis stated that gender stereotypes have a significant negative effect on the intention to choose a STEM study. The subscales of gender stereotypes had no effect on STEM intention: interests [β = 0.04, t(108) = 0.27, p = 0.79], ability [β = -0.08, t(108) = -0.60, p = 0.55], conformance [β = 0.09, t(108) = 0.57, p = 0.57]. Therefore, also this hypothesis is rejected. The last hypothesis proposed that the effect of implicit STEM ability beliefs on the intention to opt for a STEM study shrinks upon the addition of the internalization of gender stereotypes to the model. However, also the direct effect (when the mediators are included) of implicit STEM ability beliefs on the intention to choose a STEM study remained to be non-significant [β = 0.22, t(108)= -1.39, p = 0.17].

Results of the 95% confidence interval with 5,000 bootstrapping samples revealed that the total indirect effect of the mediator gender stereotypes was not significant because the interval included zero, β = -.001, SE = 0.05, 95% CI = [-.11; .08]. As well as the specific indirect effect of the mediators separately were not significant because the intervals included zero; interests: β = -.009, SE = 0.04, 95% CI = [-.08; .09], abilities: β = -.02, SE = 0.04, 95% CI = [-.10; .05], conformance: β = -.008, SE = 0.02, 95% CI = [-.02; .06]. Figure 1 displays the results and shows the different beta's regarding their p-values. In conclusion, all four hypotheses were rejected, and no mediation effect occurred of gender stereotypes on the relationship of implicit STEM ability beliefs and STEM intention.

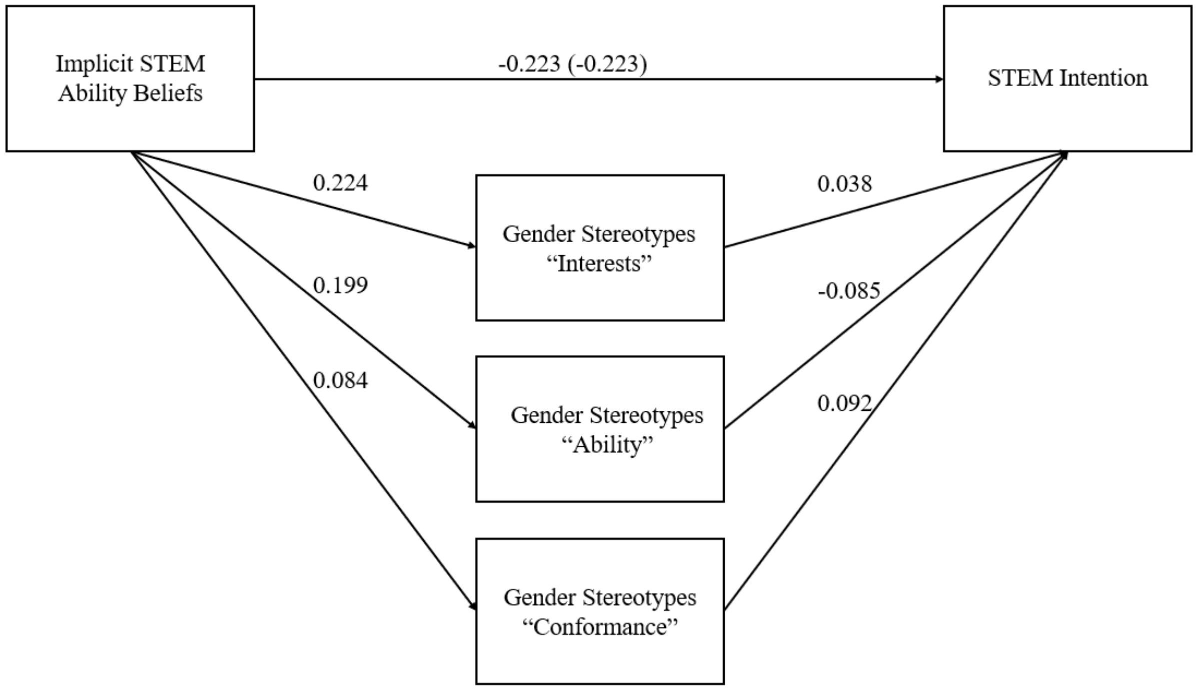

Figure 1. Mediation model of the gender stereotypes subscales (interests, ability, conformance) in the relation of implicit STEM ability beliefs and the intention to choose a STEM study.
Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

3.3. The Role of Achievement

This study also exploratory examined the role of achievement on STEM intention and gender-stereotypical beliefs. Achievement only correlated with STEM intention. Therefore, the role of academic achievement on gender-stereotypical beliefs was not further investigated. Nevertheless, the relationship of achievement on STEM intention was investigated and this appeared to be significant [$\beta = 0.19$, $t(107) = 2.15$, $p < 0.05$] which suggests that respondents with a higher grade, score higher on the intention to choose a STEM study.

4. Discussion

The study aimed to identify potential mediating roles of gender stereotypes (interests, abilities, and conformance) in the relationship of implicit STEM ability beliefs and pupils' intention to opt for a STEM study path. This study was not able to find a direct relationship between implicit STEM ability beliefs and STEM intention nor did it find a mediating role of gender stereotypical beliefs. Therefore, all hypotheses were rejected.

4.1. The Role of Gender-Stereotypes in the Relationship between Implicit STEM Ability Beliefs and STEM Intention.

The results of the study showed no empirical evidence for the mediating role of gender stereotypes on the relationship between implicit STEM beliefs and STEM intention as Van Aalderen-Smeets and Walma van der Molen (2018) suggested. These results are not in line with previous research. First, research showed that implicit STEM ability beliefs influence how sensitive students are to stereotypical beliefs (Aronson, Fried, & Good, 2002; Good, Aronson & Inzlicht, 2003; Dweck, 2008). In this way, entity beliefs positively influence the internalization of gender stereotypes. Hence, it was suggested that the higher the score on the entity scale, the higher the internalization of gender stereotypes. However, this study was not able to find this relationship properly because only a few respondents indicated to have these fixed mindsets (2.7%). Furthermore, the respondents scored exceptionally low on their internalization of gender stereotypes and the sample was rather small. These three results indicate that the participants were remarkably similar in answering the questions, therefore, no differences could be found. These low scores could be explained by the fact that the respondents gave socially desirable answers since the questions were extremely formulated and as Grimm (2010) also indicates that socially sensitive topics evoke such social desirability bias. Furthermore, it is reasonable that females in fifth-grade who are close to graduation and who already chose a STEM-oriented path in secondary school score lower on gender stereotypical beliefs toward STEM compared to females who do not chose for such a path.

Additionally, a substantive amount of studies show that implicit STEM ability beliefs influence the STEM intention (Aronson et al., 2002; Blackwell et al., 2007; Good et al., 2003; Paunesku et al., 2015; Van Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou, 2019). Nevertheless, this study was not able to find this direct relationship. Probably this again has to do with the fact that the sample was small and that respondents in this study scored exceptionally low on the entity scale. Thus, most participants thought that they could change and develop their abilities through experience and practice.

Lastly, the Expectancy-Value theory (Eccles et al, 1983), and the theory of Circumscription and Compromise (Gottfredson, 1996) could explain how gender-stereotypes can influence the intention to choose for a STEM-study but this was also not found in this study. This again, might be explained by the homogeneous group that did not indicate to suffer from the gender stereotypical image of STEM. Since the described relationships were not found, it seems reasonable that this study was not able to find a mediating role of gender stereotypes on the relationship of implicit STEM ability and STEM intention as was proposed by Aalderen-Smeets and Walma van der Molen (2018).

Despite these findings, it is a promising result that fifth-grade female preparatory university students who already chose for a STEM-oriented path do not suffer from gender stereotypical beliefs or fixed mindsets that could influence their study choice. Additionally, despite respondents scored very low on the different variables, the survey was valid and reliable since factor analysis showed support for the hypothesized factors and Cronbach's alphas were good. Furthermore, the number of girls who indicate that they are certain to opt for a STEM study path (29.1%) is similar to the national (Dutch) rate (27%; Techniekpact, 2019). It is important to mention that this study did not include studies as architecture or biomedical sciences as STEM-studies, whereas, Techniekpact (2019) did include studies like these where females are highly represented (architecture; 46% female; biomedical sciences; 70% female; VHTO, 2019). Hence, the number of girls opting for a STEM study path in this study is relatively slightly higher compared to the national number.

Next to the mediation model, this study explored the role of achievement on STEM intention and gender stereotypical beliefs. As in line with previous research (Guo, Parker, Marsh, & Morin, 2015; Rask, 2010; Wang, 2012; Wang & Degol, 2013; Watt, Eccles, & Durik, 2006), it appeared that achievement played a significant role on STEM-intention. Therefore, it seems that having good grades in a STEM subject is favourable when deciding for a bachelor's degree in this field. Hence, this study showed that academic achievement still influences the intention to opt for a STEM study path even for students who do not suffer from entity beliefs and gender stereotypical beliefs. Furthermore, studies suggested that achievement may influence the internalization of stereotypical beliefs (Appel et al. 2011; Good et al. 2008), however achievement did not correlate with the gender-stereotypes subscales. Therefore, this study was not able to find this relationship. Nevertheless, this could again be attributable to the fact that the respondents in this study scored very low on the gender stereotypes subscales.

4.2. Limitations and Directions for Further Research

The study comprises some limitations. The first shortcoming of this study could be the sample. The sample consisted of 110 participants which is rather small. Furthermore, it consisted of fifth-grade female preparatory university students who already chose a STEM-oriented track. The results showed that this was a homogenous sample because the respondents scored remarkably similar on the different variables. This appeared to affect the results since no differences between the respondents could be found in the data. The fact that there were no differences in scores is not attributable to the survey because the questionnaire appeared to have good construct validity and good reliability. This suggests that it was measuring what it was supposed to measure, and it suggests good internal consistency. Consequently, it is suggested to replicate this study with female third graders who still have to chose if they want to opt for a STEM-oriented path in secondary school. In this way, the group will be more varied which could potentially result in more differences between scores.

Furthermore, this study showed that a considerable number of female students do not choose for a STEM study path although they follow a STEM-oriented track (70.9%). Even though STEM studies may be not suited for everyone and may be relatively difficult, too many preparatory university students exclude STEM related options and studies too early. This can be described as the so-called ‘leaking STEM-pipeline’ (Tuijl & Walma van der Molen, 2016). However, it should be mentioned that females with a STEM-oriented track could also choose for these subjects because they do not know yet what to study and therefore keep all their options open. This study did not ask about the reasons why they chose a STEM-oriented track. Therefore, further research should examine these possible reasons to be able to better explain why only a minority of females chooses for a STEM-study. Furthermore, there could be other reasons to explain the leaking STEM-pipeline besides gender stereotypical thinking and entity beliefs. Therefore, it is important to examine other possible reasons.

According to Tuijl and Walma van der Molen (2016) one other interrelated factor plays a role in the ‘leaking STEM-pipeline’. This factor relates to ‘knowledge’. This concerns that students should be made more knowledgeable of the broad range of activities, opportunities, and occupations that the STEM field provides. For instance, we could make female students more aware that the STEM field also offers opportunities to help other people. Weisgram and Bigler (2006) showed that girls who had become more convinced that STEM fulfilled altruistic purposes expressed greater interest in pursuing a career in this field. However, the amount of knowledge regarding the STEM field was not tested in this study. Therefore, further research should also examine this so-called ‘knowledge’ level of female preparatory university students about STEM.

Furthermore, Van Aalderen-Smeets and Walma van der Molen (2018) proposes two additional factors ‘self-efficacy’ and ‘motivation’ that could explain the relationship between implicit STEM ability beliefs and the intention to choose for a STEM study path. Van Aalderen-Smeets, Walma van der Molen, and Xenidou-Dervou (2019) examined already the pathway of self-efficacy where they concluded that self-efficacy acted as a mediator. However, the pathway of motivation is not yet empirically investigated. Therefore, another recommendation would be to also test this hypothesized pathway. Conclusively, other possible reasons (‘reasons for

STEM-oriented path', 'knowledge level', and 'motivation') besides gender stereotypical thinking and entity beliefs for the leaking STEM-pipeline should be further investigated to be able to better understand why girls are not choosing for a STEM study path.

4.3. Practical Implications

This study investigated the role of gender stereotypical beliefs on implicit STEM ability beliefs and STEM intention. However, it did not find significant relationships because the respondents scored low on the variables. On a positive note, we could say that it is a promising result that fifth-grade university preparatory females with a STEM-oriented track do not seem to suffer from gender-stereotypical thoughts nor from fixed mindsets in opting for a STEM study. However, 70.9% of these girls do not want to choose for a STEM-study, which is equivalent to the national prevalence rate. This indicates that there is still a problem: only a minority of girls opt for a STEM study in The Netherlands. This study proposes that this problem may not be due to a fixed mindset nor gender-stereotypical beliefs. Therefore, other reasons should be further examined, such as the knowledge level of students about STEM. This can have practical implications for education since secondary schools and teachers should give a more representing picture of the STEM-field and should provide more positive female role models in STEM (Harackiewicz, Rozek, Hulleman, & Hyde, 2012). In this way, students should be made more aware of the broad range of activities, opportunities, and occupations that the STEM field offers. These small-scale interventions target students' thoughts, beliefs, and feelings which can lead to long-term improvements on the motivation and achievement of students (Yeager & Walton, 2011). This study showed that academic achievement influences the intention to opt for a STEM study path. Therefore, it is important to promote students' achievement as well. In this way, not only focusing on students' subjective experiences can influence students' achievement, positive interpersonal relationships with teachers can as well (Wang & Degol, 2013). Hence, interventions at secondary schools that target students' knowledge level about STEM, their subjective experiences, and positive interpersonal relationships with teachers are important propositions.

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6.1. Appendix A
Survey

Information about the study

Hartelijk dank dat je deze vragenlijst wilt invullen. De vragenlijst bestaat uit 35 vragen en het invullen duurt ongeveer 10 minuten. Deze vragenlijst gaat over jouw keuze en houding omtrent een bètastudie. We hebben jouw input nodig om een goed beeld te krijgen van hoe het studiekeuzeproces werkt. Er zijn bij het invullen geen goede of foute antwoorden. We willen alleen kijken hoe het in werkelijkheid zit. Het is daarom belangrijk dat je jouw eigen mening geeft zodat ons onderzoek een realistisch beeld oplevert.

Invullen. We willen je vragen de vragenlijst volledig in te vullen. Een onvolledig ingevulde vragenlijst kunnen we niet meenemen in de analyses. Hoe vul je hem in? Denk niet te lang na bij elke vraag, maar ga af op je eerste gevoel. Bij elke vraag kun je aangeven in hoeverre je het eens bent met de stelling (variërend van “helemaal niet mee eens” tot “helemaal mee eens”). Het kan lijken dat sommige stellingen sterk op elkaar lijken. Dat klopt. Dit is nodig om de vragenlijst statistisch betrouwbaar te maken, vul daarom alle vragen in.

Anoniem. De resultaten van de vragenlijst zullen anoniem verwerkt worden en niet worden gekoppeld aan jou als persoon.

Bètastudies. De meeste vragen gaan over bètavakken en bèta-vervolgopleidingen. Met bètavakken bedoelen we de vakken wiskunde (A, B & D), natuurkunde, scheikunde, biologie, informatica, techniek, NLT, onderzoeken en ontwerpen, etc. Met bèta-vervolgopleidingen bedoelen we technische en/of natuurwetenschappelijke opleidingen, bijvoorbeeld waarvoor je een van de bètavakken als ingangseis nodig hebt. Geneeskunde en bouwkunde (bijv. architectuur) wordt in deze vragenlijst niet als bèta-vervolgopleiding gezien, technische geneeskunde wel.

Namens de onderzoekers van de Universiteit van Twente, alvast bedankt voor het invullen van de vragenlijst.

Consent

Door akkoord te gaan verklaar ik mijn deelname aan een onderzoeksproject geleid door Anne Westerink, namens de Universiteit Twente.

Ik geef de onderzoeker toestemming om mijn gegevens te gebruiken voor haar bachelor thesis. Het is mij duidelijk dat ik op elk moment van de deelname, zonder opgaaf van reden, kan stoppen.

Ik heb van de onderzoeksleider de uitdrukkelijke garantie gekregen dat de onderzoeksleider er zorg voor draagt dat ik niet te identificeren ben in door het onderzoek naar buiten gebrachte gegevens, en verslag. Mijn privacy is gewaarborgd als deelnemer aan dit onderzoek.

Als ik verdere informatie wil over het onderzoek, neem ik contact op met Anne Westerink,

a.g.j.westerink@student.utwente.nl

Biographical Information

Code SPSS	Nummer	Vraag	Response schaal
GESLACHT	1	Wat is je geslacht?	Man/vrouw
LEEFTIJD	2	Wat is je leeftijd?	15, 16, 17, of 18 jaar
SCHOOL	3	Op welke school zit je?	Open
KLAS	4	In welke klas zit je?	Open
KLASNUMMER	5	Wat is je klasnummer?	Open
PROFIEL	6	Welk profiel heb je gekozen?	NT, NG, EM, CM, NT&G, E&CM
		Wat is je gemiddelde afgeronde score voor de volgende vakken? (Als je het genoemde vak niet volgt, kies dan; n.v.t.)	
CIJFER_N	7	Natuurkunde	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, n.v.t.
CIJFER_W	8	Wiskunde	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, n.v.t.
CIJFER_B	9	Biologie	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, n.v.t.
CIJFER_S	10	Scheikunde	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, n.v.t.

STEM-Intention

Code SPSS	Nummer	Vraag	Response schaal
NEIGBK	11	Hoe groot schat je de kans in dat je een bèta-vervolgopleiding gaat kiezen? (We bedoelen hier alle natuurwetenschappelijke, technische richtingen met uitzondering van Geneeskunde/Bouwkunde)	Likert-7 (Erg klein- klein- waarschijnlijk niet- 50/50- waarschijnlijk wel - groot- Erg groot)
		Als ik ga studeren…	
INTENTIEP1	12	Ben ik van plan om een natuurwetenschappelijke of technische vervolgopleiding te gaan volgen.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
INTENTIEP2	13	Ben ik van plan een studie te kiezen waar je natuurkunde en/of scheikunde voor nodig hebt.	Likert-4 (Helemaal niet mee eens- niet mee eens -

			mee eens – helemaal mee eens)
INTENTIEP3	14	Ben ik van plan om een studie te kiezen waarbij het belangrijkste accent ligt op de bèta-onderwerpen.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
INTENTIEN1	15	Ben ik van plan om een studie te kiezen die niets te maken heeft met een van de bètavakken.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
INTENTIEN2	16	Ben ik van plan een studie te kiezen waar je geen natuurkunde, scheikunde, informatica of andere bètavakken voor nodig hebt.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
INTENTIEN3	17	Ben ik van plan om een studie te kiezen waarbij het belangrijkste accent niet op de bètakant ligt.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)

<u>Implicit STEM Ability Beliefs</u>

	Code SPSS	Nummer	Vraag	Response schaal
Entity	TOIBE1	18	Ik denk dat ik niet kan veranderen hoe goed ik ben in bètavakken.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	TOIBE2	19	Hoe goed ik ben in bètavakken, is denk ik iets aan mij waar ik niets aan kan veranderen.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	TOIBE3	20	Om eerlijk te zijn, denk ik niet dat ik kan veranderen hoe goed ik ben in bètavakken.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	TOIBE4	21	Ik denk dat ik een bepaalde mate van aanleg voor de bètavakken heb en zelf niet kan veranderen hoe goed ik daarin ben.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
Incremental	TOIBI1	22	Ik denk dat ik met voldoende tijd en moeite mijn capaciteiten voor	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens –

			de bètavakken kan veranderen.	helemaal mee eens)
	TOIBI2	23	Ik geloof dat ik altijd kan veranderen hoe goed ik ben in de bètavakken.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	TOIBI3	24	Afgezien van hoe goed ik ben in de bètavakken op dit moment, denk ik dat ik het vermogen bezit om dit te veranderen.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	TOIBI4	25	Ik denk dat ik het vermogen heb om mijn capaciteiten in de bètavakken te veranderen over tijd.	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)

STEM Gender-Stereotypes

	Code SPSS	Nummer	Vraag	Response schaal
Interests	ATT_GEN1	26	Meisjes zijn minder geïnteresseerd in bètavakken dan jongens	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	ATT_GEN2	27	Meisjes vinden andere vakken dan bètavakken leuker	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	ATT_GEN3	28	Jongens hebben vaker hobby's die bèta-gericht zijn dan meisjes	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	ATT_GEN4	29	Bètastudies spreken jongens meer aan	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
Abilities	ATT_GEN5	30	Meisjes zijn minder goed in bètavakken dan jongens	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)

	ATT_GEN6	31	Meisjes hebben minder aanleg voor bètavakken dan jongens	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	ATT_GEN7	32	Meisjes zijn beter in andere vakken (zoals talen) dan bètavakken	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
Conformance	ATT_GEN8	33	Om een succesvolle bèta-gerelateerde carrière te hebben, moet je als een man kunnen denken	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	ATT_GEN9	34	Vrouwen die een bèta-gerelateerde baan hebben, moeten zich ‘mannelijk’ gedragen	Likert-4 (Helemaal niet mee eens- niet mee eens - mee eens – helemaal mee eens)
	ATT_GEN10	35	Bètavakken zijn ‘mannelijker’ dan andere vakken	Likert-4 (Niet mee eens- mee eens)

6.2. Appendix B

Translated items

Subscale	Items; Ertl, Luttenberger, and Paechter (2017)	Translated items
Interests (α = .730)	Girls are not as interested as boys in STEM subjects	Meisjes zijn minder geïnteresseerd in bètavakken dan jongens
	Girls enjoy studying other subjects more	Meisjes vinden andere vakken dan bètavakken leuker
	STEM subjects are more 'masculine' than other subjects	Moved to ‘conformance’ subscale
	Boys are more likely to have hobbies to do with STEM subjects	Jongens hebben vaker hobby’s die bèta-gericht zijn dan meisjes
	University courses in STEM subjects are likely to be more attractive to boys	Bètastudies spreken jongens meer aan
	Girls don't want to work in places that are noisy and dirty	Deleted -> not related to STEM specifically
	At home boys are more likely than girls to do practical things (e.g. with cars with a parent)	Deleted -> not related to STEM specifically
Abilities (α = .703)	Girls are not as good as boys at STEM subjects	Meisjes zijn minder goed in bètavakken dan jongens
	STEM subjects are more 'masculine' than other subjects	Moved to ‘conformance’ subscale
	STEM subjects are taught better to boys	Deleted -> says nothing about the ability of girls related to STEM
	Girls have less natural ability in STEM subjects than boys	Meisjes hebben minder aanleg voor bètavakken dan jongens
	Most girls are better at other things (like languages) and they take the subject they are best at	Meisjes zijn beter in andere vakken (zoals talen) dan bètavakken
Conformance (α = .768)	To have a successful career in STEM you need to think like a man	Om een succesvolle bèta-gerelateerde carrière te hebben, moet je als een man kunnen denken
	Women who work in STEM have to act like a men	Vrouwen die een bèta-gerelateerde baan hebben, moeten zich ‘mannelijk’ gedragen

6.3. Appendix C

Information Sheet for Participating Students

UNIVERSITY OF TWENTE.

Informatie over deelname aan een onderzoek naar:

Een evaluatie van keuze en houding omtrent een bètastudie

Aanleiding

In Nederland is er de laatste jaren een actief beleid om de keuze voor een N-profiel bij meisjes te stimuleren. Deze inspanningen werpen hun vruchten af dat terug te zien is in een stijging van de keuze voor bèta-profielen bij meisjes. We zouden verwachten dat deze ontwikkeling ook terug te vinden is in een stijging van meisjes die voor een bètastudie kiezen. Helaas is dit niet het geval. Onderzoek heeft aangetoond dat dit effect mogelijk te verklaren is vanuit verschillende factoren, zoals sociaaleconomische factoren maar ook psychologische factoren. Vanuit de psychologische invalshoek is de geringe keuze van meisjes voor bètastudies mogelijk te verklaren door een laag zelfbeeld, een vaste mindset, en ook door stereotype beeldvorming. Deze stereotype beeldvorming houdt in dat bètastudies als 'mannelijk' worden gezien. Uit onderzoek blijkt dat deze stereotypering van bètastudies in Nederland veel sterker is dan andere internationale landen. Deze sterke stereotype beeldvorming blijkt te correleren met de lage instroom van vrouwen in technische richtingen, waardoor meisjes weinig rolmodellen in ICT of techniek hebben in Nederland. In deze studie wil ik graag jouw keuze en houding omtrent een bètastudie evalueren.

Wat vraag ik van jou

Ik vraag aan jou om binnen 2 dagen een korte vragenlijst (ong. 10 minuten) in te vullen gericht op jouw keuze en houding omtrent een bètastudie. Het onderzoek vindt plaats in overleg met jouw school.

Waarborgen

Je gegevens zullen anoniem blijven. Ik noteer geen namen tijdens het onderzoek en bij de presentatie van de resultaten zullen de antwoorden niet te herleiden zijn naar individuele personen. De werving en procedure zijn afgestemd met de begeleiders van de bachelor thesis. Er zijn geen fysieke, juridische of economische risico's verbonden aan deelname aan deze studie. Je hoeft niet deel te nemen aan de studie als je dat niet wil, dus de deelname is geheel vrijwillig en kan op elk gewenst moment gestopt worden.

Wat kan het jou opleveren

Het kan je inzicht geven in factoren die jouw keuzeproces voor een vervolgstudie beïnvloeden.

Contact

Voor vragen of klachten kun je contact opnemen met Anne Westerink, Universiteit Twente, a.g.j.westerink@student.utwente.nl